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⑤④ Novel derivatives of gamma-cyclodextrin.

⑤⑦ Novel  $\gamma$ -cyclodextrin derivatives which are  $\gamma$ -cyclodextrin substituted with C<sub>1</sub>-C<sub>8</sub> alkyl, hydroxy C<sub>1</sub>-C<sub>8</sub> alkyl, carboxy C<sub>1</sub>-C<sub>8</sub> alkyl or C<sub>1</sub>-C<sub>8</sub> alkyloxycarbonyl C<sub>1</sub>-C<sub>8</sub> alkyl or mixed ethers thereof and their preparation. Compositions comprising such cyclodextrin derivatives and an active ingredient which is preferably a drug and the preparation of such compositions.

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NOVEL DERIVATIVES OF  $\gamma$ -CYCLODEXTRIN.

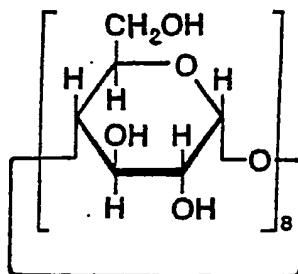
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Background of the invention

The present invention is concerned with new ethers of  
15  $\gamma$ -cyclodextrin, their preparation and their use as complexants for  
chemicals and pharmaceuticals.

$\gamma$ -cyclodextrin ( $\gamma$ -CD) is a cyclic oligosaccharide consisting of  
8 glucose units which are joined together by  $\alpha(1-4)$  linkages.

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$\gamma$ -CD is prepared by the enzymatic cleavage and religation of starch and  
a subsequent separation from the thus obtained cyclodextrin mixture  
containing i.a.  $\alpha$ -cyclodextrin (containing 6 glucose units),  
30  $\beta$ -cyclodextrin ( $\beta$ -CD) (7 glucose units) and  $\gamma$ -cyclodextrin ( $\gamma$ -CD).

Cyclodextrins are known in the art to possess the ability to form  
inclusion complexes and to have concomitant solubilizing properties. An  
exhaustive review which describes such complexes and their properties can  
be found in W. Sanger, Angewandte Chemie, 92, 343-361 (1981).

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Derivatives of cyclodextrins are also known to possess the above-mentioned properties. Said derivatives have been reviewed in an article by A.P. Croft and R.A. Bartsch in *Tetrahedron*, 39, 1417-1474 (1983). More particularly, the German Offenlegungsschrift DE 3118218 discloses the 2,6-dimethyl derivatives of  $\beta$ -CD, while in U.S. Patent No. 3,459,731 there are described hydroxyethyl, hydroxypropyl and hydroxypropyl/hydroxyethyl ethers of  $\beta$ -CD. Furthermore, in U.S. Patent Appl. Ser. No. 6-603 839 there is described the use of specific derivatives of cyclodextrines to improve the systemic administration of sex hormones. Most of the cyclodextrin derivatives presently known in the art are derived from  $\beta$ -CD, while the derivatives of  $\alpha$ -CD and particularly of  $\gamma$ -CD remain relatively unknown.

The use of derivatives of  $\beta$ -CD has the following advantages.  $\beta$ -CD is only poorly water soluble and therefore it is disadvantageous to use it as a complexant and solubilizer. Derivatives of  $\beta$ -CD on the other hand, due to their increased solubility, are more suitable complexants and solubilizers. In contrast herewith,  $\alpha$ -CD and  $\gamma$ -CD having an excellent water solubility do not need such substitutions. Hence, it is obvious to use unsubstituted  $\gamma$ -CD (and  $\alpha$ -CD) as complexant and solubilizer.

Particularly for  $\gamma$ -CD, a number of such complexes with various useful compounds can be found in e.g. *Int. J. Pharm.* 10, 1-15 (1982) with steroid hormones, in *Acta Pharm. Suec.* 20, 11-20 (1983) with flurtripofen, in *Chem. Pharm. Bull.* 31, 286-291 (1983) with spiro lacton and in *Acta Pharm. Suec.* 20, 287-294 (1983) with proscillaridin.

$\gamma$ -CD does not form such inclusion complexes with any given compound. Often, such complexation is only established in the lower concentration range. At higher concentrations of  $\gamma$ -CD, the formed complex is precipitated.

It has now been found that an appropriately alkylated, hydroxy-alkylated, carboxyalkylated or (alkyloxycarbonyl)alkylated form of  $\gamma$ -CD or a mixed ether thereof prevents the crystallization of such complexes. The advantages of  $\gamma$ -CD over its lower homologues, i.e. its larger cavity resulting in a superior propensity to form inclusion complexes, its favourable toxicological properties and the fact that it can be cleaved enzymatically by  $\alpha$ -amylase (in contrast with  $\beta$ -CD), can therefore fully be exploited.

$\gamma$ -CD contains three free hydroxy functions per glucose unit which can completely or partially be derivatized. In view of this, the average degree of substitution (D.S.) is introduced, which is the average number of substituted hydroxy functions per glucose unit. Said D.S. can vary  
5 from its minimal value 0.125 up to its maximal value 3. In the latter case all 24 hydroxy groups are substituted, while in the former case only one is substituted. A minimal D.S. is especially preferred when  $\gamma$ -CD is used as solubilizer of pharmaceuticals for use in parenteral applications, while a higher D.S. is preferred when used in technical  
10 applications, such as, for example, for pesticides or enzymes. In the latter instance, the higher D.S. causes that also those hydroxy groups are functionalized which are located in the cavity of the  $\gamma$ -CD molecule. Consequently, the diameter of the cavity is decreased. By selecting the appropriate D.S. the size of the cavity can be adapted in  
15 order to obtain the optimum space required for a certain molecule to appropriately fit into the cavity of the cyclodextrin.

When introducing hydroxyalkyl substitutions on  $\gamma$ -CD, the hydroxy function of the thus obtained hydroxyalkyl ether group can further be hydroxyalkylated, generating multiple substitutions on one particular  
20 OH-group. In such cases the term average molar substitution (M.S.) is introduced. Said M.S. is defined as the average number of moles of the substituting agent per glucose unity. In view of this, it is evident that the M.S. can be greater than 3 and has, theoretically, no upper limit.

#### 25 Description of the preferred embodiments.

The present invention is concerned with novel  $\gamma$ -CD derivatives, said novel  $\gamma$ -CD derivatives being  $\gamma$ -CD substituted with  $C_1-C_6$   
alkyl, hydroxy  $C_1-C_6$  alkyl, carboxy  $C_1-C_6$  alkyl or  $C_1-C_6$   
30 alkyloxycarbonyl  $C_1-C_6$  alkyl or mixed ethers thereof.

In the foregoing definitions the term " $C_1-C_6$ -alkyl" is meant to include straight and branched saturated hydrocarbon radicals, having from 1 to 6 carbon atoms, such as, methyl, ethyl, 1-methylethyl,

1,1-dimethylethyl, propyl, 2-methylpropyl, butyl, pentyl, hexyl and the like.

Preferred compounds are those  $\gamma$ -CD derivatives being  $\gamma$ -CD substituted with  $C_1$ - $C_3$  alkyl, hydroxy  $C_2$ - $C_4$  alkyl, carboxy  $C_1$ - $C_2$  alkyl or ( $C_1$ - $C_2$  alkyloxycarbonyl) $C_1$ - $C_2$  alkyl or mixed ethers thereof.

Particularly preferred new compounds are the methyl, ethyl, isopropyl, hydroxyethyl, hydroxypropyl, hydroxybutyl, carboxymethyl and carboxyethyl substituted  $\gamma$ -cyclodextrins and further the (methyl)(hydroxyethyl), (methyl)(hydroxypropyl) and (methyl)(hydroxyethyl)(carboxymethyl) substituted  $\gamma$ -cyclodextrins having a D.S. or M.S. of from 0.125 to 3, more preferably of from 0.3 to 2.

The compounds of the present invention can generally be prepared by reacting the starting  $\gamma$ -CD with an appropriate  $O$ -alkylating agent or a mixture of such agents in a concentration being selected so that the desired D.S. is obtained. The said reaction is preferably conducted in a suitable solvent in the presence of an appropriate base. An appropriate  $O$ -alkylating agent is, for example, an alkyl, hydroxyalkyl, carboxyalkyl or (alkyloxycarbonyl)alkyl halide or sulfonate, e.g. methyl chloride, ethyl bromide, propyl methylsulfonate, ethyl chloroacetate,  $\alpha$ -chloroacetic acid; or an oxirane, e.g. oxirane, methyloxirane. Suitable solvents are, for example, water; an alcohol or polyalcohol, e.g. methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 1,2-ethanediol, 1,2-propanediol and the like; a ketone, e.g. 2-propanone, 2-butanone, 4-methyl-2-pentanone, and the like; an ether or polyether, e.g. ethoxyethane, 2-(2-propyloxy)propane, tetrahydrofuran, 1,2-dimethoxyethane and the like; and  $C_1$ - $C_4$ -alkyloxy- $C_2$ - $C_3$ -alkanol and mixtures of such solvents. An appropriate base is, for example, an alkali or earth alkaline metal hydroxide, e.g. sodium hydroxide, potassium hydroxide; or an alkali or earth alkaline metal hydride or amide, e.g. sodium hydride, calcium hydride, sodium amide and the like bases.

Preferably the said O-alkylation reaction is conducted with 0.1 to 3 parts by weight of water per part by weight  $\gamma$ -CD in case there is no organic solvent used, and with 1 to 40 parts by weight organic solvent per part by weight  $\gamma$ -CD in case no water is used.

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In a particularly preferred way of preparing the compounds of the present invention, the reaction mixture containing the starting  $\gamma$ -CD, the solvent, base and O-alkylating agent is heated in an autoclave at a temperature comprised between 30° and 200°C. Depending on the reactivity  
10 of the O-alkylating agent, the reaction mixture is allowed to react at this temperature for 15 minutes up to 24 hours. Subsequently, the mixture is acidified and the reaction product is isolated and purified by standard separation and purification procedures such as, for example, column chromatography, ultra filtration, centrifugation, and dried.

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The compounds of the present invention can also be converted into each other. For example, the (alkyloxycarbonyl)alkyl substituted  $\gamma$ -cyclodextrines may conveniently converted to the corresponding carboxyalkyl substituted  $\gamma$ -cyclodextrines following art-known  
20 saponification procedures, e.g. by treating the starting compounds with an aqueous acidic or basic solution.

The compounds of the present invention are useful due to their ability to form inclusion complexes having a stabilizing effect on the  
25 complexed compounds, and due to their concomitant solubilizing activity. Compounds exhibiting a significantly increased water solubility and improved stability after having been transferred to inclusion complexes with the above-mentioned  $\gamma$ -CD derivatives, are those having the required shape and size, i.e. which fit into the cavity. The size of the  
30 cavity can be adapted by selecting the appropriate  $\gamma$ -CD derivatives having a suitable D.S. Examples of such compounds are, for example, non-steroid anti-rheumatic agents, steroids, cardiac glycosides and derivatives of benzodiazepine, benzimidazole, piperidine, piperazine,

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imidazole, triazole, pyridazine, 1,2,4-triazinedione or 2,3,5,6-tetrahydro-imidazo[2,1-b]thiazoles, or amides, hydratropic acid derivatives or trialkylamines, whereby the derivatives of benzodiazepine, benzimidazole, piperidine, piperazine, imidazole, triazole, pyridazine, 1,2,4-triazinedione or 2,3,5,6-tetrahydro-imidazo[2,1-b]thiazole, or amides, hydratropic acid derivatives or trialkylamines are preferred.

Useful benzimidazole derivatives are thiabendazole, fuberidazole, ciclo bendazole, oxibendazole, parbendazole, cambendazole, mebendazole, fenbendazole, flubendazole, albendazole, oxfendazole, nocodazole and astemizole.

Suitable piperidine derivatives are diphenoxylate, phenoperidine, haloperidol, haloperidol decanoate, bromperidol decanoate, bromperidol, moperone, trifluoperidol, pipamperone, piritramide, fentanyl, benperidol, droperidol, benztiramide, benzetimide, domperidone, sufentanil, carfentanil, alfentanil, dexetimide, milenperone, difenoxin, fluspirilene, penfluridol, pimizide, lorcainide, loperamide, astemizole, ketanserine, levocabastine, cisapride, altanserine, ritanserine, 3-[2-[4-(4-fluorobenzoyl)-1-piperidinyl]ethyl]-2,7-dimethyl-4H-pyrido[1,2-a]pyrimidin-4-one, 3-[2-[4-[bis(4-fluorophenyl)methylene]-1-piperidinyl]-ethyl]-2-methyl-4H-pyrido[1,2-a]pyrimidin-4-one and 3-[2-[4-[[3-(2-furanylmethyl)-3H-imidazo[4,5-b]pyridin-2-yl]amino]-1-piperidinyl]ethyl]-2-methyl-4H-pyrido[1,2-a]pyrimidin-4-one. Suitable piperazine derivatives include azaperone, fluanisone, lidoflazine, flunarizine, mianserine, oxatomide, mioflazine, clocinazine and cinnarizine.

Examples of suitable imidazole derivatives are metronidazole, ornidazole, ipronidazole, tinidazole, isoconazole, nimorazole, miconazole, burimamide, metiamide, metomidate, enilconazole or imazalil, etomidate, econazole, clotrimazole, carnidazole, cimetidine, doconazole, sulconazole, parconazole, orconazole, butoconazole, triadiminole, tioconazole, valconazole, fluotrimazole, ketoconazole, oxiconazole, lombazole, bifonazole, oxmetidine, fenticonazole, tubulazole and (Z)-1-[2-chloro-2-(2,4-dichlorophenyl)ethenyl]-1H-imidazole.

As suitable triazole derivatives there may be mentioned virazole, azaconazole, etaconazole, propiconazole, penconazole, itraconazole and terconazole.

Useful pyridazine derivatives are, for example, 3-chloro-6-[3,6-dihydro-4-(3-methylphenyl)-1(2H)-pyridinyl]pyridazine, 3-methoxy-6-[4-(3-methylphenyl)-1-piperazinyl]pyridazine and the compounds of Publ. Eur. Pat. Appl. No. 0,156,433.

Useful 1,2,4-triazinediones are, for example, 2-chloro- $\alpha$ -(4-chlorophenyl)-4-(4,5-dihydro-3,5-dioxo-1,2,4-triazin-2(3H)-yl)benzeneacetonitrile, 2,6-dichloro- $\alpha$ -(4-chlorophenyl)-4-(4,5-dihydro-3,5-dioxo-1,2,4-triazin-2(3H)-yl)benzeneacetonitrile and the compounds of Publ. Eur. Pat. Appl. No. 0,170,316.

Useful trialkylamines are, for example, diisopromine, prozapine.

Useful 2,3,5,6-tetrahydro-imidazo[2,1-b]thiazoles comprise, for example, tetramisole or levamisole.

Useful amides are, for example, closantel, ambucetamide, isopropamide, buzepide metiodide, dextromoramide.

A useful hydratropic acid derivative is, for example, suprofen.

Particularly valuable pharmaceutical compositions are obtained when converting etomidate, ketoconazole, tubulazole, itraconazole, levocabastine or flunarizine into a water-soluble form using the complex forming agents of the invention. Such compositions are therefore a special subject of the present invention.

The invention is further directed to a method of preparing compositions of sparingly water-soluble or water-unstable compounds which method is characterized by dissolving the  $\gamma$ -cyclodextrin ether in water and adding thereto the selected compound as well as optionally drying the solution of the formed inclusion compound using methods known per se. Formation of the solution may preferably take place at temperatures between 15 and 35°C.



The drug is suitably added batchwise. The water may further comprise physiologically compatible compounds such as sodium chloride, potassium nitrate, glucose, mannitol, sorbitol, xylitol or buffers such as phosphate, acetate or citrate buffer.

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Using  $\gamma$ -cyclodextrin ethers in accordance with the invention it is possible to prepare commonly known application forms of drugs for oral, parenteral, topical, rectal or vaginal application, e.g. infusion and injection solutions, drop solutions (e.g. eye drops or nasal drops),  
10 sprays, tablets, powders, capsules, aerosols, sirups, jellies, ointments, medical baths, rectalia and vaginalia.

The aqueous solutions may further comprise suitable physiologically compatible preserving agents such as, for example, quaternary ammonium  
15 soaps, chlorbutanol, phenoxetol, bromopol, and the like, and also anti-oxidantia, such as, for example, ascorbic acid.

For the preparation of solid formulations the solutions of the inclusion compounds are dried using conventional methods; thus the water  
20 may be evaporated in a rotation evaporator or by lyophilisation. The residue is pulverized and, optionally after addition of further inert ingredients, converted into uncoated or coated tablets, suppositories, capsules, creams or ointments.

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Examples

The following examples are meant to illustrate and not to limit the present invention in all its aspects. Unless stated otherwise, all parts therein are by weight.

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A. Preparation examples.Example 1

1 Part of  $\gamma$ -CD and a solution of 1.5 parts of sodium hydroxide in  
10 1.5 parts of water were mixed in an autoclave. Then there were added 3  
parts of methyl chloride and 0.5 parts of methyloxirane. The mixture was  
heated for 1 hour at 65°C and subsequently for 2 hours at 100°C. After  
cooling, the remaining methyloxirane was expelled and the reaction  
mixture was neutralized with hydrochloric acid. The volatile components  
15 were evaporated and the remainder was filtered. The filtrate was  
liberated from sodium chloride over an ion exchanger and subsequently  
freeze-dried, yielding the (methyl)(hydroxypropyl) derivative of  $\gamma$ -CD.  
Following the same procedures and using the appropriate starting  
materials the (ethyl)(hydroxyethyl) derivative of  $\gamma$ -CD was also  
20 prepared.

Example 2

In an autoclave there were mixed 2.5 parts of 1,2-dimethoxyethane, 1  
part of  $\gamma$ -CD and a solution of 1 part of sodium hydroxide in 1.2 parts  
25 of water. To this mixture, there were added 2 parts of oxirane and the  
whole was heated to 110°C for 5 hours. After cooling, the remaining  
oxirane was expelled and the reaction mixture was neutralized with  
hydrochloric acid. The volatile components were evaporated and the  
remainder was filtered. The filtrate was subsequently liberated from  
30 sodium chloride over an ion exchanger and subsequently freeze-dried,  
yielding the hydroxyethyl derivative of  $\gamma$ -CD with a M.S. of 0.77.

Following the same procedures and using the appropriate starting  
materials there was also prepared the 2-hydroxypropyl derivative of  
 $\gamma$ -CD with a M.S. of 0.66.

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Example 3

1 Part of  $\gamma$ -CD, 3 parts of 1,2-dimethoxyethane and 1.5 parts of sodium hydroxide in 1.5 parts of water were mixed in an autoclave. Subsequently, there were added 4 parts of chloromethane and the whole was  
5 heated at 120°C for 4 hours. After cooling the reaction mixture was neutralized with hydrochloric acid and the volatile components evaporated. The remainder was filtered and the filtrate was liberated from sodium chloride over an ion exchanger and subsequently freeze-dried, yielding the methyl derivative of  $\gamma$ -CD with a D.S. of 1.49.

10 Following the same procedures and using the appropriate starting materials there were also prepared the methyl derivative of  $\gamma$ -CD with a D.S. of 0.13; the carboxymethyl derivative of  $\gamma$ -CD with a D.S. of 0.86; and the (ethoxycarbonyl)methyl derivative of  $\gamma$ -CD; the ethyl derivative of  $\gamma$ -CD; the butyl derivative of  $\gamma$ -CD; the isobutyl derivative of  
15  $\gamma$ -CD; the isopropyl derivative of  $\gamma$ -CD; the carboxyethyl derivative of  $\gamma$ -CD; the 3-hydroxypropyl derivative of  $\gamma$ -CD; and the 4-hydroxybutyl derivative of  $\gamma$ -CD.

B. Examples illustrating the properties of the  $\gamma$ -CD derivatives

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Example 4

Starting from a 5% stock solution of a particular  $\gamma$ -CD derivative in a phosphate buffer of pH 7.4, a dilution series was obtained with concentrations varying of from 0% to 5% with 0.5% steps. 3 ml of these  
25 solutions were pipetted into a closed container containing an appropriate amount of progesteron. After 5 days shaking at 25°C, the thus obtained mixture was filtered over a membrane filter (pore diameter: 0.22  $\mu$ m), and the content of progesteron was determined with high pressure liquid chromatography (using a column of 25 cm length; 5 mm internal diameter;  
30 packed with 5  $\mu$ m ODS-hypersil (RP-18); eluent: acetonitrile/water; U.V. detection). The results of these concentration measurements for a number of the  $\gamma$ -CD derivatives of the present invention and for unsubstituted  $\gamma$ -CD gathered in the following table.

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concentration of $\gamma$ -CD derivative in % (weight by volume)	content of progesteron in $\mu\text{g/ml}$					
	unsubsti- tuted $\gamma$ -CD	methyl substi- tuted D.S.=0.13	methyl substi- tuted D.S.=1.49	carboxy- methyl subst. M.S.=0.86	hydroxy ethyl subst. M.S.=0.77	hydroxy propyl subst. M.S.=0.66
0	5.9	5.9	5.9	5.9	5.9	5.9
0.5	425	488	379	102	234	302
1	343	972	748	209	452	582
1.5	275	1458	1144	313	673	872
2	203	1902	1470	417	860	1165
2.5	163	2149	1888	517	1055	1431
3	93	2258	2260	610	1291	1704
3.5	60	2392	2686	79	1472	1987
4	54	2592	3050	796	1722	2287
4.5	46	2627	3411	891	1817	2595
5	45	2602	3876	979	2065	2865

Table: Content of progesteron in solutions containing various concentrations of  $\gamma$ -CD derivative and  $\gamma$ -CD.

Example 5.

Following the procedures described in example 4 the content of 3-chloro-6-[3,6-dihydro-4-(3-methylphenyl)-1(2H)-pyridinyl]pyridazine was determined in solutions containing various concentrations of  $\gamma$ -CD derivatives. Said pyridazine compound is described in Published Europ. Pat. Appl. No. 0,156,433 as a useful anti-viral agent.

concentration of $\gamma$ -CD derivative in % (weight by volume)	content of 3-chloro-6-[3,6-dihydro-4-(3-methylphenyl)- 1(2H)-pyridinyl]pyridazine in $\mu\text{g/ml}$		
	unsubstituted $\gamma$ -CD	methyl- substituted D.S.=1.49	hydroxypropyl substituted M.S.=0.66
0	0.4	0.4	0.4
1	2.0	2.0	1.5
2.5	0.8	8.0	4.5
3.5	-	12.6	7.0
5	0.8	20.0	10.0

### C. Composition examples.

#### 20 Example 6

In 100 ml water 7 g hydroxyethyl- $\gamma$ -CD (M.S. = 0.77) and 0.5 g medroxyprogesterone acetate were dissolved. The water was evaporated. 75 mg of the residue was powdered and mixed with 366 mg  $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ , 60 mg corn starch, 120 mg cellulose powder (microcrystalline), 4.2 mg highly dispersed silica (Aerosil® 200) and 4.8 mg magnesium stearate and pressed to a tablet.

#### Example 7

5 g hydroxyethyl  $\gamma$ -cyclodextrin (M.S. = 0.77) and 0.5 g lidocaine were dissolved in 100 ml of a physiological sodium chloride solution at 30°C and filtered through a membrane filter (0.45 microns). The solution was filled into ampules and sterilized.

CLAIMS

- 1 1. A  $\gamma$ -cyclodextrin ether or mixed ether wherein the ether  
2 substituents are  $C_1-C_6$  alkyl, hydroxy  $C_1-C_6$  alkyl, carboxy  
3  $C_1-C_6$  alkyl or ( $C_1-C_6$  alkyloxycarbonyl) $C_1-C_6$  alkyl.
- 1 2. A  $\gamma$ -cyclodextrin ether or mixed ether according to claim 1  
2 wherein the ether substituents are  $C_1-C_3$  alkyl, hydroxy  $C_2-C_4$   
3 alkyl or carboxy  $C_1-C_2$  alkyl.
- 1 3. A  $\gamma$ -cyclodextrin derivative according to claim 1, wherein the  
2 substituents are methyl, ethyl, isopropyl, hydroxyethyl, hydroxypropyl,  
3 hydroxybutyl, carboxymethyl and carboxyethyl.
- 1 4. A  $\gamma$ -cyclodextrin derivative according to any of claims 1-3  
2 wherein the degree of substitution is in the range of 0.125 to 3 and  
3 the M.S. is in the range of 0.125 to 10.
- 1 5. A  $\gamma$ -cyclodextrin derivative according to any of claims 1-3,  
2 wherein the degree of substitution is in the range of 0.3 to 2 and the  
3 M.S. is in the range of 0.3 to 3.
- 1 6. A process for preparing a compound as defined in any of the  
2 claims 1-5, characterized by reacting  $\gamma$ -cyclodextrin with an  
3 O-alkylating agent.
- 1 7. A process according to claim 6, wherein the process is conducted  
2 in a reaction-inert solvent in the presence of a base and at a  
3 temperature in the range from 30° to 200°.
- 1 8. A composition comprising an active ingredient and a  
2  $\gamma$ -cyclodextrin derivative as claimed in any of claims 1-5.
- 1 9. A composition according to claim 8, wherein the active ingredient  
2 is a drug.

1        10. A composition according to claim 9, wherein the drug is a  
2 non-steroid anti-rheumatic agent, a steroid, a cardiac glycoside or a  
3 derivative of benzodiazepine, benzimidazole, piperidine, piperazine,  
4 imidazole, triazole, pyridazine, 1,2,4-triazinedione, 2,3,5,6-tetra-  
5 hydroimidazo[2,1-b]thiazole or hydratropic acid, or an amide or  
6 trialkylamine derivative.

1        11. A composition according to claim 8 wherein the drug is  
2 etomidate.

1        12. A composition according to claim 8 wherein the drug is  
2 ketoconazole.

1        13. A composition according to claim 8 wherein the drug is  
2 itraconazole.

1        14. A composition according to claim 8 wherein the drug is  
2 flunarizine.

1        15. A method of preparing a composition according to anyone of  
2 the claims 8-14, characterized in that the  $\gamma$ -cyclodextrin ether is  
3 dissolved in water and that the active ingredient is added whereafter  
4 the thus obtained solution is optionally dried.

1        16. A method according to claim 15, wherein the residue after  
2 removal of the solvent is pulverized and, optionally after addition of  
3 further ingredients, converted into a solid form for administration.

1        17. A method according to claims 15 or 16, wherein further  
2 physiologically acceptable substances are added to the water.

1        18. A method according to claim 17, wherein sodium chloride,  
2 glucose, mannitol, sorbitol, xylitol or a phosphate or citrate buffer  
3 are added to the water.

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Novel derivatives of gamma-cyclodextrin.

57 Novel  $\gamma$ -cyclodextrin derivatives which are  $\gamma$ -cyclodextrin substituted with  $C_1-C_6$  alkyl, hydroxy  $C_1-C_6$  alkyl, carboxy  $C_1-C_6$  alkyl or  $C_1-C_6$  alkyloxycarbonyl  $C_1-C_6$  alkyl or mixed ethers thereof and their preparation. Compositions comprising such cyclodextrin derivatives and an active ingredient which is preferably a drug and the preparation of such compositions.

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# EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	WO-A-8 200 251 (U.S. DEPARTMENT OF COMMERCE) * Page 2, lines 22-23; page 7, lines 12-22; claim 3 *	1-5,8-10	C 08 B 37/16 A 61 K 31/735
X	--- PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON CYCLODEXTRINS, 30th September - 2nd October 1981, Budapest, HU, pages 275-287, edited by J. SZEJTLI, D. Reidel Publishing CO., Dordrecht, NL; A. LIPTAK et al.: "The chemistry of cyclodextrin derivatives" * Page 278, paragraph 3; page 279, paragraphs 2,3 *	1-7	
A	--- CHEMICAL ABSTRACTS, vol. 98, no. 2, 10th January 1983, page 225, abstract no. 8163z, Columbus, Ohio, US; & JP-A-57 106 698 (KYOWA HAKKO KOGYO CO., Ltd.) 02-07-1982 * Abstract *	15,16	TECHNICAL FIELDS SEARCHED (Int. Cl.4)  C 08 B A 61 K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15-07-1987	Examiner SOMERVILLE F.M.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document  T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons  & : member of the same patent family, corresponding document			



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P,X	JOURNAL OF PHARMACEUTICAL SCIENCES, vol. 74, no. 9, September 1985, pages 987-990, American Pharmaceutical Association, Washington, US; J. PITHA et al.: "Amorphous water-soluble derivatives of cyclodextrins: nontoxic dissolution enhancing excipients" * Table 1; page 989, paragraph 2; page 990, paragraph 5 *  -----	1-5, 8-10	
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